# Pulsed arterial spin labeling perfusion in healthy aging and early dementia

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**Introduction:** Cerebral blood flow (CBF) is correlated to neuronal activity and cerebral metabolic rate [1]. Pulsed arterial spin labeling (PASL) perfusion imaging is a magnetic resonance imaging (MRI) technique relying on the detection of magnetically labeled water, which permits safe and economical multiple repeated measurements, and has been proven to be an useful instrument for the investigation of brain pathologies [2,3]. Alzheimer's Disease (AD), being the most common cause of dementia, is a neurodegenerative disorder, leading to cerebral structural alterations, as well as to changes in neurotransmitter systems in the cortical association areas and the limbic system [4]. The transitional clinical phase between normal cognition and dementia in AD is usually referred to as mild cognitive impairment (MCI) [5]. The aim of the present study was to determine regional cerebral perfusion changes in patients with MCI and AD as compared to cognitively normal young and elderly controls using a PASL technique.

**Subjects and Methods:** MRI was performed on a 3 T whole body MR scanner (body coil for transmit;8-channel head coil for receive). A multislice STAR sequence [6] with WET presaturation [7] and thin slice periodic saturation pulses (Q2TIPS) [8] was used for PASL: readout single-shot EPI; TR/TE/$\alpha$ = 2500ms/17ms/90°; TI1/TI1S/TI2 = 700ms/ 1200ms/1500ms; 11 slices (aligned to Hippocampus, comprising parietal lobe); matrix 64x63; voxel size 3.75x3.75x6mm$^3$; gap 0.6mm; 80 pairs of labeled-control; scan time 7min 18sec). For coregistration a single shot EPI (voxel size 3.75x3.75x3 mm$^3$; 40 slices) and a T1-weighted TFE sequence (voxel size 1x1x1 mm$^3$; 170 slices) were acquired in the same session. Calculation of CBF-maps was performed as described previously [9] and included correction for partial volume effects [10]. Resting CBF maps were obtained from 16 young (30±10a) and 15 elderly (65±5a) cognitively normal controls, 13 patients with MCI (69±9a) and 7 patients diagnosed with mild dementia in AD (70.9±11.2a). After spatial coregistration and normalization, analysis of variance was performed across groups using SPM5 (http://www.fil.ion.ucl.ac.uk/spm). Results were thresholded at p<0.05, corrected for family wise error (FWE).

**Results:** Results are summarized in Fig. 1 and Table 1. Lower perfusion was found in the left and right superior and inferior parietal cortex and in the right angular gyrus both in patients with MCI and AD as compared to cognitively normal controls. A small but statistically significant reduction of perfusion in the parietal cortex and the left caudate was also detected in elderly controls compared to young controls.

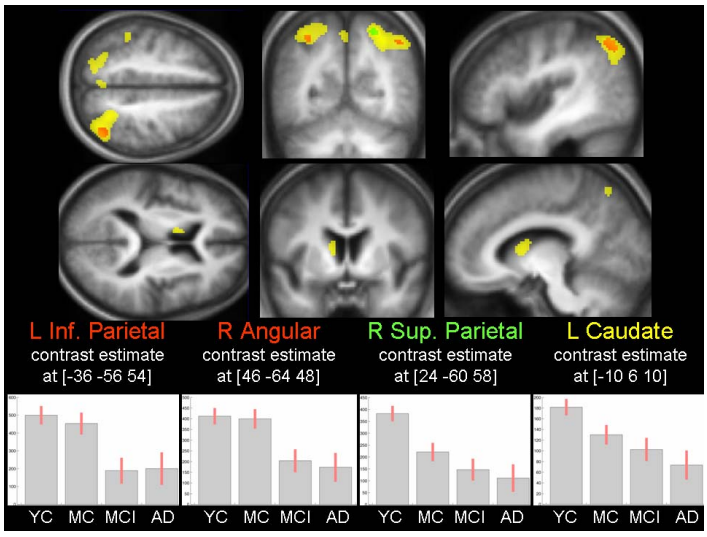


**Fig 1:** Sections showing regional CBF differences: young controls (YC) > matched elderly controls (MC) > patients with MCI > patients with AD (yellow), YC > MC (green), MC > MCI & AD (red) (p < 0.05 FWE corrected).

**Table 1:** Peak MNI coordinates of CBF differences

| Anatomic location | x | y | z | z-value |
|---|---|---|---|---|
| **young controls > elderly controls > MCI > AD** (yellow) | | | | |
| R Sup. Parietal | 26 | -58 | 56 | 5.80 |
| R Angular | 46 | -64 | 48 | 5.48 |
| L Sup. Parietal | -20 | -62 | 60 | 4.85 |
| L Inf. Parietal | -36 | -56 | 56 | 5.44 |
| L Caudate | -10 | 6 | 10 | 5.04 |
| **young controls > elderly controls** (green) | | | | |
| R Sup. Parietal 24 | -60 | 58 | 4.64 | |
| **elderly controls > MCI & AD** (red) | | | | |
| R Angular | 46 | -64 | 48 | 4.85 |
| L Inf. Parietal | -34 | -60 | 52 | 4.48 |

**Conclusion:** These results confirm previous findings of hypoperfusion in parietal areas of patients with MCI and AD as compared to age matched controls. In addition, we found small but significant perfusion decreases in elderly- in comparison to young controls in the parietal lobe and the left caudate. This suggests that PASL is capable of identifying perfusion deficits associated with neurodegenerative disorders and may be a valuable tool for investigating the transition from normal ageing to dementia.

**References:** [1] Gonzalez et al. AJNR 16:1763-1770 (1995). [2] Golay & Petersen. Neuroimaging Clin N Am 16:259-268 (2006). [3] Wintermark et al. J Neuroradiol 32:294-314 (2005). [4] Blennow et al. Lancet 368(9533):387-403 (2006). [5] Winblad et al. J Intern Med 256:240-246 (2004). [6] Edelman & Chen. MRM 40:800-805 (1998). [7] Ogg et al. J Magn Reson B 104:1-10 (1994). [8] Luh et al. MRM 41:1246-1254 (1999). [9] Nöth et al. JMRI 24:1229-1235 (2006). [10] Johnson et al. Radiology 234:851-859 (2005).